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SAFETY SYSTEM FOR A MEANS OF TRANSPORTATION AND A METHOD RELATING TO THE SAME

Technical Area

The present invention relates to a safety system, in particular an accident avoidance system, according to the preamble of Claim 1 and a method for operating such a safety system.

Background Information

Active safety is one of the focuses in the development of present-day and also future vehicle systems. Known systems in the area of active safety, meaning accident avoidance, are, for example the electronic stability program (ESP) for stabilizing a vehicle by braking intervention in extreme driving situations as well as vehicle dynamics management (VDM) as an extension of ESP through additional steering interventions.

Besides vehicle stabilization systems, systems for triggering emergency braking are also known, which automatically intervene when a danger of a collision is detected, for example, based on environmental detection using radar and/or video sensors.

Furthermore, a large number of park assist devices are known which assist a driver when parking in a great variety of ways. Thus a park assist device is known from printed publication DE 198 09 416 A1 which calculates a parking strategy as a function of the size of the potential parking space and informs the driver of the motor vehicle of this parking strategy; however, it leaves it up to the driver to decide whether to use the parking strategy.

Furthermore, in dangerous situations, average drivers often have problems with avoiding obstacles through a suitable steering maneuver. It is thus seen, for example, in driver safety training that steering is performed too late, too fast or too slowly, too much or too little or even not at all and in addition, that countersteering is performed incorrectly or not at all, for example, in a double lane change. This results either in a collision with an obstacle or an instability, for example, skidding of the vehicle.

Printed publication EP 0 970 875 A2 describes a system intended to use steering actuators to prevent the driver from setting a steering angle leading to a collision or which automatically

sets an avoidance course if necessary. In this system, the technical system decides if, when and in what direction an avoidance is made, thus relieving the driver of this. However, a technical implementation of this avoidance decision requires a high expense for sensors and brings up legal problems in terms of liability law, for example.

Description of the Invention: Object, Achieving the Object, Advantages

Proceeding from the disadvantages and inadequacies described above and with consideration of the outlined related art, the object of the present invention is to refine a safety system of the type referred to above as well as a method of the type referred to above in such a way that an avoidance maneuver initiated by the operator of the means of transportation when approaching an obstacle is supported with respect to both the device and the method, thus preventing an accident through collision or skidding.

This object is achieved by a safety system including the features specified in Claim 1 and in Claim 4 as well as a method including the features specified in Claim 5 and in Claim 9. Advantageous embodiments and expedient enhancements of the present invention are indicated in the relevant dependent claims.

In the safety system according to the present invention or in the method according to the present invention, the evaluation unit determines from the conditions detected by the detection unit in the form of data and information at least one driving variation, in particular at least one avoidance trajectory and/or at least one automatic emergency braking (AEB) action.

If the operator of the means of transportation initiates or has initiated a corresponding driving maneuver, in particular an avoidance maneuver or an emergency braking maneuver, the function of the safety system, in particular of the evaluation unit or of the method is then initiated to the effect that this driving maneuver is specified, supported and/or suggested in an optimized form, in particular in the form of an optimal avoidance trajectory or in the form of automatic emergency braking (AEB). In dangerous situations, this system significantly increases driving safety.

In an advantageous embodiment of the present invention, the steering system suggests to the operator of the means of transportation in an emergency avoidance situation the optimal avoidance trajectory, for example, in the form of an induced or applied steering torque and/or

by a suitable haptic steering assist, thus also making safe avoidance possible even for inexperienced drivers.

The haptic steering assist may send a haptic signal, for example, in the form of at least one oscillation or at least one vibration and in this way inform the driver of a motor vehicle of the optimal avoidance trajectory, for example. The present invention thus includes a steering assist which is used, for example, for avoidance in emergencies.

Advantageously, the safety system or the method detects an approaching collision as well as the dimensions and distances to the obstacle using environmental detection sensors, for example, using radar and/or using video; these sensors may be attached at least to the front but also, if necessary, to the side and/or the rear of the vehicle.

Expediently, in the event at least the danger of a collision with an obstacle exists, the evaluation unit (= computer unit) calculates and/or suggests at least one optimal avoidance trajectory for the momentary situation

- both for a driving maneuver, for example, an avoidance to the left
- and for a driving maneuver, for example, an avoidance to the right
  which makes it possible to drive past the obstacle while maintaining driving stability.

In an embodiment essential to the present invention, the optimal avoidance trajectory in the corresponding direction is not specified until the driver initiates or has initiated an avoidance maneuver, either to the left or to the right, by turning the steering wheel. The specification may be

- haptic, for example, via an induced steering torque and/or
- the driver may override it at any time.

An advantage of this strategy is that the driver makes the extremely complex decision as to whether, when and in what direction the avoidance is made, thus reliably avoiding legal problems, in particular those relating to liability law.

In an advantageous embodiment of the present invention, in the event of danger, in particular a high risk of a collision, the evaluation unit sends at least one acoustic, haptic and/or optic

warning and/or initiates automatic emergency braking (AEB) if no other driving variation, in particular no avoidance trajectory, is available.

The safety system according to the type explained above, in particular the evaluation unit according to the type explained above, and/or the method according to the type explained above, advantageously parameterizes, prepares and/or activates the steering system and/or the chassis of the means of transportation and/or the brake system in the event of danger, in particular in the event of a high risk of collision, so that the handling characteristics of the means of transportation are optimized for a driving maneuver to be performed by the operator of the means of transportation, in particular an avoidance maneuver or an emergency braking maneuver.

As an alternative to this, the present invention may relate to a safety system according to the type explained above, in particular an evaluation unit according to the type explained above as well as a method according to the type explained above, the steering system and/or the chassis of the means of transportation and/or the brake system being parameterized, prepared and/or activated in the event of danger, in particular in the event of a high risk of a collision, so that the handling characteristics of the means of transportation are optimized for a driving maneuver to be performed by the operator of the means of transportation, in particular an avoidance maneuver or an emergency braking maneuver.

The present invention finally relates to the use of at least one safety system according to the type described above and/or a method according to the type described above in at least one driver assist system for increasing the safety, in particular the avoidance of accidents in road traffic. Thus, for example, an emergency brake system (automatic emergency brake, AEB) may be extended by steering actuators within the context of the present invention.

Description of the Drawing

As has already been explained above, there are various possibilities for embodying and enhancing the teaching of the present invention in an advantageous manner. To this end reference is made to the claims subordinate to Claims 1 and 5, and additional embodiments, features and advantages of the present invention will be elucidated in greater detail with reference to the three exemplary embodiments illustrated by Figures 1 through 3.

Figure 1	shows a first exemplary embodiment of a safety system according to the present invention in schematic form, which functions according to the method of the present invention;
Figure 2	shows a second exemplary embodiment of a safety system according to the present invention in schematic form, which functions according to the method of the present invention; and
Figure 3	shows a third exemplary embodiment of a safety system according to the present invention in schematic form, which functions according to the method of the present invention.

Identical or similar embodiments, elements or features are provided with identical reference numerals in Figures 1 through 3.

Description of the Exemplary Embodiments

To avoid unnecessary repetitions, the following explanations with respect to the embodiments, features and advantages of the present invention (if not indicated elsewhere) refer both to the first exemplary embodiment of a safety system 100 shown in Figure 1 as well as the second exemplary embodiment of a safety system 100' shown in Figure 2 as well as the third exemplary embodiment of a safety system 100" shown in Figure 3.

The particular schematic workflow of a safety system 100 or 100" for steering assist and for automatic emergency braking assist in an emergency, namely for an abrupt avoidance of an obstacle, is shown in Figures 1 and 3.

In a first step, internal and external conditions, specifically the parameters and the environment of a motor vehicle, are detected. To implement this function, safety system 100 has a detection unit 10 for environmental detection; the operation of this environmental detection unit 10 is based on, among other things, radar sensors 12 and video sensors 14.

Furthermore, using additional sensors 16, detection unit 10 is used additionally to detect data and information concerning the road traveled, for example, data and information concerning the number and width of lanes as well as the position of the host vehicle and of a potential colliding vehicle relative to the lanes. Data and information of a digital map 18 of a navigation system, for example, are also included in detection unit 10. Vehicle

communications, vehicle-infrastructure communications and data of the host vehicle are also possible as additional information sources, the latter even being necessary.

The conditions detected are merged in the form of data and information by a sensor data merging module 22 and then evaluated by an evaluation module 24 with respect to the particular hazard potential; in particular the danger of a collision for the means of transportation is determined. Accordingly, detection unit 10 is used to detect objects in front of, to the side of and to the rear of the vehicle; they are compiled using sensor data merging module 22 and evaluated with respect to the danger of a collision for the vehicle using evaluation module 24.

After the danger of a collision is determined, an avoidance algorithm is prepared, i.e., a calculation module 26 calculates cyclically possible driving variations or avoidance trajectories which make safe and stable avoidance possible using the data and information concerning the obstacle and road, and data concerning the host vehicle. For example, if an obstruction occurs on the regular road surface, at least one optimal avoidance trajectory is calculated for the momentary situation for both an avoidance variation to the left as well as an avoidance variation to the right.

If an avoidance is no longer possible and it is thus not possible to determine avoidance trajectories or no avoidance trajectory exists, automatic emergency braking (AEB) (reference numeral 50) is triggered.

From the depiction of Figure 1 as well as of Figure 3, it is evident that sensor data merging module 22, evaluation module 24 and calculation module 26 are combined in an evaluation unit 20.

If in a situation of a high danger of collision, the operator of the means of transportation initiates (reference numeral L) a driving maneuver, i.e., the operator starts an (avoidance) steering maneuver by a corresponding steering motion, a suitable steering system, for example, a steer-by-wire system, suggests (reference numeral 30) an avoidance trajectory to the operator. Thus the optimal avoidance trajectory suggested to the driver at the time of or after determination 26 of the optimal avoidance trajectory is linked V with initiation L of the driving maneuver.

The driver is informed of this optimal avoidance trajectory in the form of an induced or applied steering torque 40, the driver

- being able to follow the suggested optimal avoidance trajectory or
- being able to override the suggested optimal avoidance trajectory (reference numeral S); overriding S of the optimal avoidance trajectory by the operator of the means of transportation is thus possible at any time.

It is conceivable to provide the driver with the optimal avoidance trajectory and/or the applied steering torque in the form of at least one haptic signal, for example, in the form of at least one oscillation or in the form of at least one vibration.

If the danger of collision is high, the driver may optionally be warned before the collision, for example, by an acoustic, haptic and/or optic warning.

To assist in avoidance in emergencies, safety system 100 or 100" (see Figure 1 and Figure 3, respectively) detects and evaluates the danger of collision with obstacles in front of the host vehicle and avoidance trajectories are calculated. If the driver initiates an avoidance maneuver, the driver may be given a haptic steering assist which suggests to him/her an optimal avoidance trajectory.

A safety system 100' for avoidance assistance in emergencies is shown in Figure 2, the safety system having an evaluation unit 20' which is different from Figures 1 and 3. Evaluation unit 20' compiles data and information of detection unit 10 (reference numeral 22) and detects the danger of a collision with obstacles in front of the host vehicle (reference numeral 24).

When a danger of a collision is detected (and in view of an approaching avoidance maneuver by the driver), evaluation unit 20' parameterizes or prepares (reference numeral 60) the steering actuators and/or the brake system, in particular a brake assist and/or ESP, and/or an active chassis that may be present in such a way that the handling characteristics of the vehicle are optimized to an avoidance maneuver or emergency braking maneuver, for example, with respect to the position of the vehicle center of gravity, with respect to the steering characteristic, with respect to the damping or suspension and/or with respect to the roll stabilization.

In this safety system 100' according to Figure 2, determination 24 of the danger of collision is thus followed by optimization 60 of the steering and of the chassis for the avoidance or the emergency braking maneuver.

This system provided for optimization 60 of the steering and the chassis may be, as shown in Figure 2, configured as an independent version, i.e., without the suggestion of an avoidance trajectory or, as shown in Figure 3, in combination with the haptic output of an avoidance trajectory explained with reference to Figure 1.